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UNITED STATES DEPARTMENT OF AGRICULTURE

Austrian Winter Field Pea Diseases and Their Control in the South[1]

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CONTENTS

INTRODUCTION

The Austrian Winter field pea (*Pisum arvense* L.) has been grown for a number of years as a winter cover and green-manure crop in certain of the Southern States. During this time diseases no doubt have been present in some degree, but it is only in more recent years that the damage has been particularly severe. In the last few years the extent of disease in the growing crop has greatly increased, and in some localities diseases have become so destructive that the growing of the pea [2] has been practically abandoned. Other factors, such as nematodes, poor inoculation, and poorly drained or unfertile soils, have contributed to such failures. This discussion, however, will be limited to the diseases of this crop that are most destructive and, therefore, of greatest economic importance in the Southern States. Cultural information regarding the crop can be procured from the United States Department of Agriculture, Washington, D. C., or from State agricultural experiment stations.

DISEASES

The Austrian Winter field pea is susceptible to most of the diseases affecting the English garden pea (*Pisum sativum* L.).[3] The one exception that should be noted is that of the leaf and pod spot caused

[1] Cooperative investigations between the Division of Forage Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture, and the Georgia Experiment Station, Experiment, Ga.

[2] The term "pea" as used in this circular refers to the Austrian Winter field pea only.

[3] Harter, L. L., Zaumeyer, W. J., and Wade, B. L. Pea diseases and their control. U. S. Dept. Agr. Farmers' Bul. 1735, 25 pp., illus. 1934.

by *Ascochyta pisi* Lib. The Austrian Winter field pea is so highly resistant to this fungus that no further mention of it will be made. Several other diseases of the English garden pea are of no practical importance in the Austrian Winter field pea culture in the South, although they may be found occasionally.

Distribution and Importance

The diseases of the Austrian Winter field pea are widespread but vary greatly in their severity in different localities and from year to year. For example, one disease may be of considerable importance in one locality and be almost absent from another. A great variation in the severity of the diseases as a whole or of any given disease may occur even in nearby fields or in the same field. This variation may be explained in part by the differences in soil and air drainage, thickness of the stand, rankness of the growth, amount of rainfall, fogs, winds, elevation, previous crop history, proximity to other pea fields, possibly soil type, soil fertility, or other factors. Since the fungi and bacteria that cause these diseases are so dependent upon humidity and other climatic conditions for their spread and development, it is easy to understand why they should be influenced by any factor that changes these conditions.

Because of the variability of these diseases it is difficult to determine which is most destructive. In general, however, the diseases may be ranked according to their importance in descending order as follows: Leaf spot and black stem (*Ascochyta pinodella* Jones and *Mycosphaerella pinodes* (Berk. and Blox.) Stone), leaf blotch (*Septoria pisi* West.), root rot (largely *Aphanomyces euteiches* Drechs.), powdery mildew (*Erysiphe polygoni* DC.), bacterial blight (*Phytomonas pisi* (Sack.) Bergey et al.), downy mildew (*Peronospora pisi* Syd.), mosaic (virus), fusarium root rot (*Fusarium* sp.), and stem rot (*Sclerotinia sclerotiorum* (Lib.) Mass.). These diseases are discussed in this order.

Leaf Spot and Black Stem

SYMPTOMS

The symptoms of the diseases produced by the two fungi *Ascochyta pinodella* and *Mycosphaerella pinodes* on the leaves and stems and other parts of the pea plants are largely indistinguishable without the aid of a microscope, hence these diseases will be discussed together and no attempt made to distinguish between them. On the leaves both fungi cause brownish to almost black spots, circular or irregular in outline (fig. 1) and ranging in size from a mere dot to about one-half of an inch in diameter. The spots may coalesce and eventually kill the leaves, petioles, tendrils (fig. 2), and in extreme cases the young pods (fig. 3). The number of spots ranges from an occasional one to many. The points of infection may be so numerous and the spots remain so small and superficial that a russetlike appearance is produced on the leaves and stems (fig. 4). The larger spots may have a somewhat concentric ring character (fig. 5). Minute dark-brown to black pycnidia frequently develop in the larger spots, especially under moist conditions. On the stems, petioles, and tendrils a more or less uniform blackening is produced. This blackening may start at any

FIGURE 1.—*A*, Healthy leaf of Austrian Winter field pea. *B*, *C*, *D*, Leaves severely affected with leaf spot and black stem. Some of the spots are very small; others are much larger. Both types of spot are quite common in pea fields. The tendrils and petioles are badly blackened on *C* and *D*.

point, but often appears first at or slightly below the soil line and works upward, killing the leaves and often girdling the stem (fig. 6). The blackening of the stem is so characteristic of the disease that the name "black stem" appears to be very appropriate. The entire circumference or only a spot here and there on the stem may be involved. These spots may later coalesce. As the tissue is killed, pycnidia appear often

FIGURE 2.—*A*, Healthy Austrian Winter field pea stem and leaves. *B*, Two stems badly affected with leaf spot and black stem; leaves and tendrils have been killed.

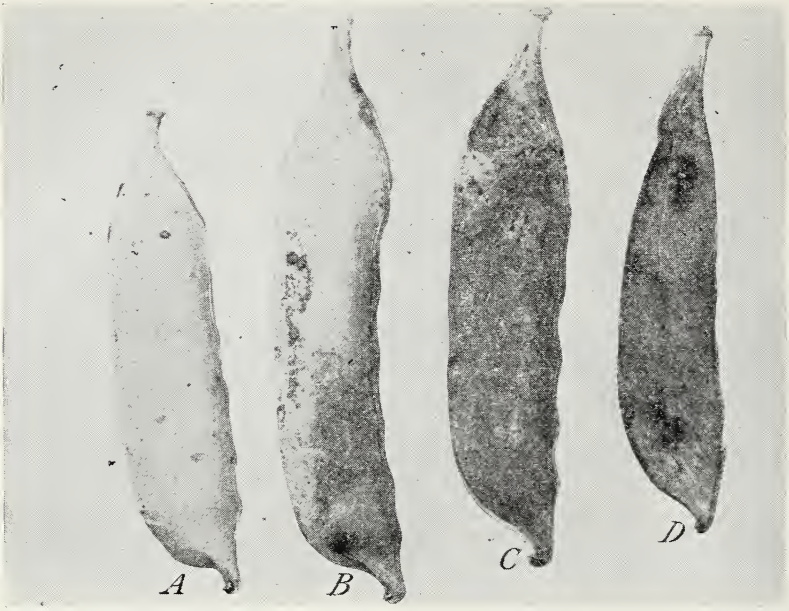

FIGURE 3.—*A*, Healthy pod; *B*, *C*, *D*, pea pods affected with leaf spot and black stem fungi.

in great abundance. Tissue frozen or injured by hail is very susceptible to these diseases. Pycnidia are produced in abundance in the injured tissue, and the disease spreads rapidly if other conditions are suitable.

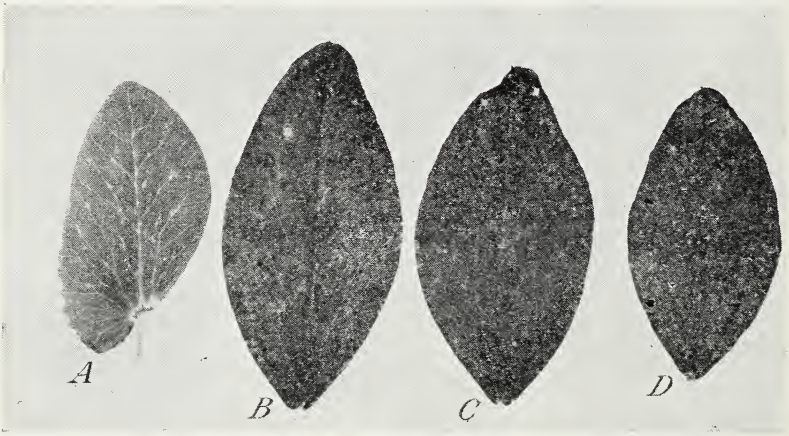

FIGURE 4.—*A*, Healthy leaf; *B*, *C*, *D*, leaves blackened by black stem fungi. This superficial blackening is characteristic of the work of these fungi.

FIGURE 5.—A distinct spot with some concentric rings produced by *Mycosphaerella pinodes* on field pea leaves. Compare with the superficial blackening illustrated in figure 4.

FIGURE 6.—Typical black stem on pea seedlings. The stems are blackened for various distances above the crown. The leaves are dead as far up the stem as the blackening goes in most cases. The left-hand stems of the plant at the extreme right have been killed by the fungus; the other stem was still alive.

ORIGIN AND SPREAD OF THE DISEASES

The fungi causing these diseases may be carried to a field in several ways. The seed may have the causal fungi on or inside the seed coat. From there the young seedling can readily be attacked, if, indeed, it had not already been infected while still within the seed coat. The fungus spores also can be brought into a field by the wind, drainage water, animals, tools, and in old pea vines, in manure, or in other ways. Perhaps one of the most common sources of the disease in a field where field peas have been grown the previous year is the soil, or pieces of the stems in the soil. Commonly the stem is attacked just below the soil surface in late autumn. The fungus grows up through the stem causing it to become dark brown to black in color. Later, spores are formed that may, when suitable conditions prevail (high humidity for 24 hours or longer and favorable temperature), attack the stems, leaves, or other part of the plant or neighboring plants.

The fact that the fungi that cause leaf spot and black stem can live over from one crop to another (April or May to October) in old stems has been demonstrated. Pieces of old pea stems only partly decayed have been picked up from the ground in September in a field where peas grew the preceding spring, and the fungi that cause leaf spot and black stem have been isolated from them. Likewise, old pea stems have been enclosed in wire cloth and held out of doors, and the fungi have been recovered from them after 13 months. The fungi have also been isolated from old pea stems held dry in the laboratory for more than 14 months.

Plants have become infected when pieces of old diseased pea stems from the previous season's crop collected in the field in October were crushed and placed on healthy pea leaves and kept moist for 48 hours. One of the fungi (*Ascochyta pinodella*) lived for 9 months in a fruit jar on soil alone. The experiments summarized show conclusively that the fungi that cause leaf spot and black stem can live in the South at least more than a year in the old stems and one of them can live for 9 months or longer in very dry soil alone. Records in the literature show that under some conditions *A. pinodella* can live in the soil for 2 years or longer. It is impossible to tell just how long these fungi can live in the soil in the average field, because the conditions vary so greatly even in different parts of the same field. It is safe to assume, however, that more or less of the fungi will be alive 2 years after diseased peas have been grown on the soil.

CONTROL

The fungi causing these diseases are widespread throughout the United States, hence no quarantine or similar measure would be of any value. Therefore it is important to prevent the fungi from accumulating to an extent that will seriously affect the crop.

SEED TREATMENT

Practically all of the pea diseases are seed-borne and hence can be brought into the field on or in the seed. Because a large proportion of the Austrian Winter field pea seed used in the South comes from the Pacific Northwest where it is grown under conditions not suitable

for the rapid development of these diseases, the seed used is for the most part relatively free of disease-producing fungi. Many of the seeds produced in parts of the South carry either on or within them the fungi that cause one or more of the diseases. Seed-treatment experiments in which seed from the Pacific Northwest and from the South was used failed to show any appreciable increase in disease-free plants by late spring. For the present no seed treatment is recommended.

AGING OF THE SEED

The question is sometimes asked whether the seed-borne diseases can be controlled by holding the seed over for a year or two. Experiments have shown that these fungi commonly live in the infected seed for 2 years, and instances are reported showing that seeds still contained the living fungus after 5 years. Since these fungi can survive in the seed for so long and since the vitality of the seed rapidly decreases, aging for the control of these diseases is not recommended.

DUSTING

Pea diseases probably could be reduced to some extent by spraying or dusting, if such treatment were economically feasible. Because some of the diseases start near or below the soil level it is impossible to combat them, even in the early stages. Later the vines become so matted together that it is impossible to apply a protective covering to much of the plant, especially the under sides of the leaves. Also, the season (late winter and spring) during which protection is necessary is relatively long and usually rainy. This would necessitate many applications under very adverse conditions.

A preliminary dusting experiment was conducted in order to learn whether a better seed crop could be obtained. Seven applications of sulfur and six of a 20–80 copper-lime dust were made at 2-week intervals during late winter and early spring. No visible control of leaf spot or black stem was obtained. Some increase in green weight was shown in the copper-lime plot, but none in the sulfur plot. The difference was not sufficiently great to justify the expense of making the applications.

ROTATION

Despite the fact that the fungi causing leaf spot and black stem can live in the soil for a long time, it has been determined that considerable benefit can be derived from a relatively short rotation. These diseases are usually not serious the first year peas are planted on disease-free land. The second year the diseases are somewhat more prevalent and destructive, and after a few years considerable damage may result (fig. 7). However, the rate at which the fungi accumulate in the soil and hold over from one crop to the next varies greatly with conditions. Dry seasons are not conducive to disease development, hence during a dry season the disease-producing fungi may increase little in the soil or may even decrease. Peas planted on the same land every year may be very heavily infected with leaf spot and black stem in a rainy year and be almost free of these troubles the following year, if the weather is dry.

General field observations, as well as experimental demonstrations, seem to justify the conclusion that if peas are planted on the same

land not oftener than 1 year out of 3 or 4, the losses to the cover crop because of leaf spot and black stem should not be severe. This presupposes that the rotated field is not adjacent to a badly diseased field that may furnish an abundance of fungus spores to inoculate the plants in the rotated field. It is also necessary that during the period when Austrian Winter peas are not used as a cover crop on a piece of land no other crop plant susceptible to the disease-producing fungi should be planted. Hairy and purple vetches should not be used in the rotation, as they are susceptible to the black stem fungi, although

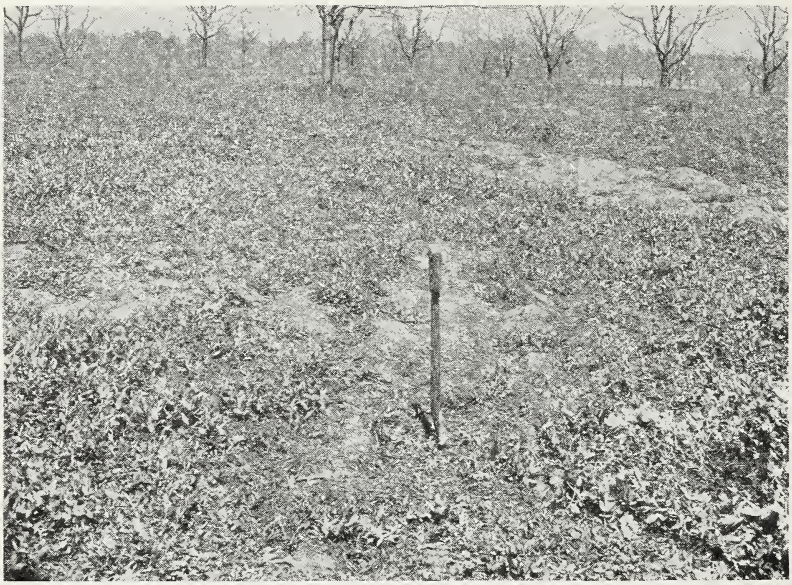

FIGURE 7.—Seventh consecutive crop of Austrian Winter field peas grown in this pecan grove. This crop would have been good had not the plants in large areas been killed by the leaf spot and black stem fungi. The remaining plants were greatly injured. The dead vines on the ground in the bare areas show that there was originally a good stand of plants.

to a somewhat lesser degree than is the Austrian Winter field pea. Monantha, common, and Hungarian vetches are highly resistant to these pea diseases but not to some of those discussed later, especially root rot. The Tangier pea is moderately susceptible to black stem and leaf spot. Grain-crop plants are not susceptible to the pea diseases and may be used in the rotation with peas for disease control. Crimson clover is susceptible to the stem rot fungus (*Sclerotinia sclerotiorum*) discussed later but not to the other pea fungi. However, as the stem rot fungus is seldom found in fields of Austrian Winter field peas in the South, at least in Georgia, crimson clover probably can be used in the rotation with little danger. Close observation should be maintained to see whether this disease increases, and if it does crimson clover should not be planted on land to be used later for peas. Bur-clover (*Medicago arabica* Huds.) is not susceptible to these pea diseases.

It should be emphasized that rotation will not insure complete freedom from diseases; however, it should prevent serious damage. It is

the most satisfactory method that can be suggested at this time for keeping the losses at a minimum.

RESISTANT VARIETIES

At the present time no resistant strains of the Austrian Winter field pea and no other variety that can be substituted for it are known.

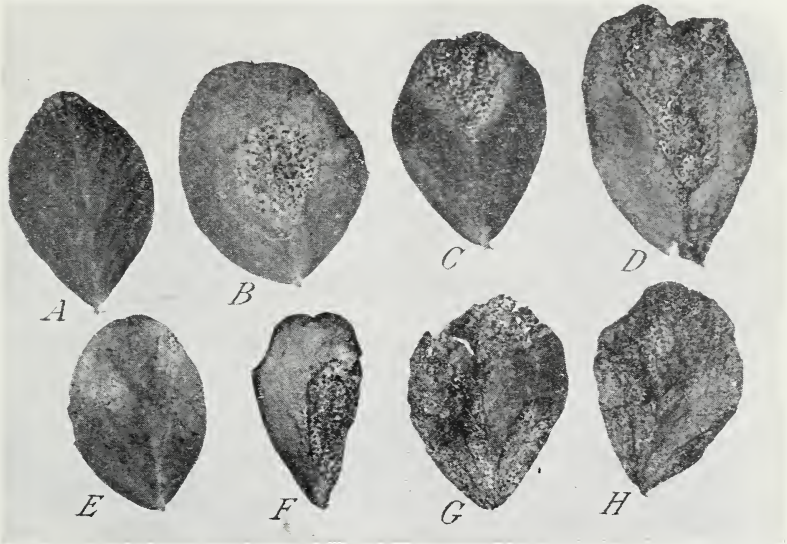

FIGURE 8.—Austrian Winter pea seedling leaves infected with the leaf blotch disease. *A*, Healthy leaf. The infected area may be initiated in the central part of the leaflet as in *B*, be terminal as in *C* and *D*, be marginal as in *E* and *F*, or more than one spot may originate in different parts of the leaflet and eventually involve most or all of it as has occurred in *G* and *H*.

An effort is being made by plant breeders in several Southern States to obtain by selection and breeding more highly resistant strains of peas.

LEAF BLOTCH

SYMPTOMS

Leaf blotch is usually the first disease to appear on seedling peas in the autumn, often being found a month or so after they have been planted. The disease attacks the first leaves, causing a yellowing and gradual killing of the tissues. The affected area may start at one side or at any other point of the leaf blade and involve a large portion of it. At this stage one spot may kill an entire leaf. Minute pycnidia, which are brown at first but later black, appear scattered about in the affected area (fig. 8). The fungus may not only involve and kill the whole leaf, but may run down the petiole and girdle the stem so that the portion of the stem above dies. New buds usually will be sent out below the girdle and new stems replace, at least temporarily, those killed. This disease does not go very far up or down the stem from the node. The fungus continues to spread, however, forming new blotches, killing leaves, petioles, tendrils, and sometimes even young pods. The dead tissue usually is dotted with pycnidia (figs. 9 and 10).

FIGURE 9.—Stems, leaves, petioles, and tendrils of pea plants killed by the leaf blotch fungus. Note the very fine dots along petioles and tendrils. These are pycnidia or fruiting bodies of the fungus and are filled with spores that are blown about and start new infections.

FIGURE 10.—Field pea pods (variety not known) affected with leaf blotch fungus. The light-colored areas are the healthy tissue and the dark spots are diseased tissue. Note again the pycnidia, as shown in figure 9. The darkest-colored areas were reddish in color.

ORIGIN AND SPREAD OF THE DISEASE

The leaf blotch fungus, like those causing leaf spot and black stem, can be carried to the field in the seed or by animals, water, wind, tools, and other agencies. This fungus can also live over in the soil and in the old stems. It is reported to have lived in old stems in a protected place for at least a year.

CONTROL

The fungus that causes leaf blotch is widespread. The wind, no doubt, carries it over considerable distances, and it lives and accumulates in the soil as do the fungi that cause leaf spot and black stem if

FIGURE 11.—*A*, Healthy plant; *B*, *C*, *D*, plants affected by root rot. The decayed roots are darker in color than the healthy. Note that the dark color does not go as high as the crown. This disease has stopped at about the place the black stem would start. The diseased plants are considerably stunted.

peas are grown continuously on the same land. Most of the control methods suggested for black stem will apply to the leaf blotch fungus (pp. 6–9).

ROOT ROT

SYMPTOMS

The presence of root rot is not easily detected in its early stages. Its presence may be suspected when the plants, most commonly in low, poorly drained areas, become stunted and yellowish and gradually die. If such plants have root rot, the roots will have a light-brown, often water-soaked appearance but will usually be firm. The entire root is affected in advanced stages (fig. 11), but in earlier stages only a small section near or below the point where the remnants

of the old seed are attached is discolored. The disease is not often visible for more than an inch above ground. The secondary roots may be entirely decayed and disintegrated. The affected root eventually shrivels, and the plant dies. With suitable growing conditions for the plant and less suitable ones for the causal fungus, new rootlets may be put out above the diseased part of the root and the plant may outgrow the disease even when the original root is badly decayed.

Root rot stunting should not be confused with a somewhat similar dwarfing due to other causes. For example, plants whose roots failed to become inoculated with the nodule-forming bacteria may have very similar above-ground symptoms. An examination of the roots of such plants, however, will show that they are entirely white and healthy but lack nodules. Other plants may be stunted and often yellow because the roots are affected with other types of root rot, with nematodes, or with some more obscure trouble. Similar symptoms may result when the stem near or just below the surface of the soil has been girdled by the black stem or leaf blotch fungi or by freezing.

ORIGIN AND SPREAD OF THE DISEASE

Root rot varies greatly in severity. It may kill the plants over large areas of the field or only in small usually wet spots. Although affected roots may be found in January or sometimes earlier, few plants die before February or later, depending upon weather conditions. Usually all of the plants in an affected area are more or less diseased. This disease is due to one or more fungi that commonly live in the soil and only need suitable conditions, principally high soil moisture, for attacking the pea plant. Thus the disease is not seed-borne. The causal fungi, if not already widespread in a field, can be distributed by water, wind, tools, and any other agency capable of transferring the soil from one place to another.

CONTROL

Root rot is sometimes the most serious of the pea diseases because it can kill a large portion of the plants while they are still small. Since it is a soil-borne disease, such measures as seed treatment and spraying are valueless. Low, wet pieces of ground should not be planted to peas, and surface drainage should be promoted. These fungi live for a number of years in the soil, therefore, as long a rotation as practicable should be used if root rot becomes destructive. No resistant varieties suitable for growing in the South are known.

Powdery Mildew

Powdery mildew usually is not of much importance when the pea crop is plowed under early for green manure, but it does become abundant and destructive in late spring. This disease is especially important when seed growing is attempted. At first only a leaf here and there may have one or more spots, but eventually all the leaves of all the plants are attacked, usually starting on the older leaves and gradually working toward the top until all the leaves, stems, and pods may be more or less covered with the white mildew (fig. 12). The fungus attacks other plants, from which it can be carried to the pea plant. It is also said to live over in the seed.

FIGURE 12.—*A*, Healthy leaf; *B*, *C*, leaves made white by the powdery mildew fungus.

CONTROL

Powdery mildew can be controlled by spraying or dusting, but this procedure is not practical on a field scale, especially since the crop is usually ready to plow under before the disease becomes serious. Crop rotation is of little value, probably because of the abundance of wild hosts. Resistant strains of peas are known and are being used in an attempt to breed resistance into the Austrian Winter field pea.

BACTERIAL BLIGHT

Bacterial blight usually is not very important on the Austrian Winter field pea, as far as present knowledge goes, but it does some damage in certain localities some years. It produces olive-green to olive-brown water-soaked areas of varying sizes on the stems, leaves, and pods, and under favorable conditions it may kill the plants. Infected plants have not been seen until early spring. The bacteria that cause the disease can live over in the seed. As far as known, most of the seed from the Pacific Northwest is relatively free of the disease.

Rotation as recommended for the control of the other diseases will also hold bacterial blight in check.

DOWNY MILDEW

Downy mildew is present in varying amounts during most seasons, but it is seldom of much economic importance. The disease is first noted by the presence of yellowish areas of various sizes on the upper surface of the leaves. An examination of the lower surface reveals the presence of a violet-colored moldlike mass of conidiophores of the fungus. The leaves may be killed and a few stems dwarfed, but the loss from this disease usually is not severe and no control measures are needed. The black stem fungi sometimes enter the tissue infected by the downy mildew fungus and contribute to the damage done.

Mosaic

Several mosaic diseases of peas are recognized that cause a mottling of yellowish and green color in the leaves. These are of little importance, however, in the pea crop under discussion and will not be considered further.

Fusarium Root Rot

Fusarium root rot is sometimes seen in the young plants in the autumn and may cause some decrease in stand, but it is so rare that it need be given little attention here. The causal fungus attacks the base of the stem at or just above the point of attachment of the old seed. Laboratory study is usually necessary to distinguish this disease from some other root rots. The affected tissue is usually dark brown to reddish in color. The causal fungus lives in the soil and should be largely held in check by a rotation practice such as recommended for the other diseases.

Stem Rot

Stem rot is common in parts of Oregon, where much of the Austrian Winter field pea seed used in the South is grown, but it is not commonly seen in the southern pea fields. At or near the surface of the ground the stem is attacked and decays, and the plant wilts, turns brown, and dies. Under wet conditions, a white fungus growth is often apparent on the outside of the plants. The fungus may also be seen in the pith area of the stem. Black masses of fungus tissue, called sclerotia, may be present in the decayed tissue. These sclerotia may be carried with the seed and thus serve to spread the disease. The rotation practice previously advised (pp. 7–9) should keep this disease in check.

SUMMARY

The Austrian Winter field pea is grown as a winter cover and green-manure crop in several Southern States. This plant is attacked by a number of diseases, some of which have increased so much in severity during the last few years that the growing of the crop is restricted in certain localities.

The most important diseases are leaf spot and black stem, leaf blotch, root rot, and powdery mildew; but bacterial blight, downy mildew, mosaic, fusarium root rot, and stem rot are responsible for more or less loss.

The leaf spot and black stem fungi live over from one crop season to the next, principally in the soil or in pieces of diseased stems. Since field conditions are so variable, it is impossible to estimate just how long these fungi can live in the soil, but they have been found to live 2 years or longer. The fungi can be brought to the field in or on the seed and by wind, water, or other agencies. The amount of the fungi in the soil increases from year to year if peas are planted on it each autumn. Although the diseases will not be eliminated entirely by rotation, if peas are not planted on the same land oftener than 1 year out of 3 or 4, the losses can be reduced to a minimum. Susceptible crops such as hairy vetch and the Tangier pea should not be used in the rotation. Crimson clover, bur-clover, and cereals are not suscep-

tible. Monantha, common, and Hungarian vetches, although probably not immune, are highly resistant to the leaf spot and black stem fungi. No resistant varieties that can be substituted for the Austrian Winter field pea are known.

Leaf blotch kills much leaf tissue and often girdles young stems. The disease varies greatly in severity from season to season and in different localities. Losses can be held to a minimum by rotation such as recommended for the control of leaf spot and black stem.

Root rot may kill the plants in certain areas and thus cause almost a total loss of the crop. No satisfactory control measure is known, but low wet areas should not be used and the rotation should be as long as practicable.

Powdery mildew is often prevalent, especially in the extreme southern part of the pea-growing area, and although it seldom does much damage by the time the crop is ready to plow under, it may become important when seed growing is attempted.

Bacterial blight, downy mildew, mosaic, fusarium root rot, and stem rot are found at times, but usually do little damage. Rotation should help to hold these diseases in check.

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